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L27 and medication	8

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Set Name side by side	Query	Hit Count	Set Name result set
DB=PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD; PLUR=YES; OP=OR			
L28	L27 and medication	8	L28
L27	L26 and (online or on-line or internet or network or www)near order$	8	L27
L26	pharmacy near system	331	L26
L25	L23 and (formulary or ingredient or medical)near records	97	L25
L24	L23 and formulary near records	0	L24
L23	L22 and database	490	L23
L22	L21 and clients	512	L22
L21	l20 and servers	1149	L21
L20	L19 and networks	8417	L20
L19	(pharmaceutical or pharmacy) and administration	145340	L19
L18	709/224	4956	L18
L17	709/223	4736	L17
L16	709/213	1505	L16
L15	709.clas.	26771	L15

L14	700/90	1078	L14
L13	705/10	2145	L13
L12	705/9	997	L12
L11	705/4	842	L11
L10	705/3	1032	L10
L9	705/2	1393	L9
L8	705/1	4216	L8
L7	707/104.1	3656	L7
L6	700/231	439	L6
L5	700.clas.	37138	L5
L4	707/100	4213	L4
L3	707.clas.	19106	L3
L2	705.clas.	25337	L2
L1	705/26	4347	L1

END OF SEARCH HISTORY

DEVELOPMENT OF AN OPERATIONAL MEDICAL NETWORK (MEDNET) MODEL

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Abstract - **This investigation describes the development of a new fault tolerant Medical Network (MEDNET) model based on the existing Public Switch Telephone Network (PSTN), Integrated Services Digital Network (ISDN) and Internetworking (Internet). This research includes the original design, development and testing of the required hardware and software interfaces to provide a complete Medical Network model. MEDNET ties the Doctor, the Patient, the Hospital, the Medical Lab, and the Pharmacy for near real time and fault tolerant exchange of medical information. The MEDNET model includes the following modules: 1. Central Database Server, 2. Remote Client Access, and 3. Communication Interface. This work proves that medical images and data can be exchanged between healthcare providers which are not geographically adjacent, in a cost effective, timely, and secure manner[1].**

INTRODUCTION

MEDNET is a comprehensive medical networking system which can interface to standard POTS analog modems, Internet, and primarily the Integrated Services Digital Network (ISDN). MEDNET is a network that can interconnect healthcare providers, such as clinics, hospitals, private and state medical offices, pharmacies, and insurance companies into a single and integrated system which allows all qualified personnel to access a patient's data file in near real time. FIGURE 1 is a system diagram of MEDNET.
The MEDNET system is implemented using a UNIX based system, Sun Spark 10, as a file server. A user can access the file server through either analog modem, Internet or ISDN. In the case of modem access, the user may obtain access to the file server by dialing a telephone number to be connected to the terminal server. As for Internet access, the user can Telnet to the file server from any machine that has Internet connection capability. Finally, the user may use an ISDN line to interconnect to the file server.

Currently, the maximum baud rate of a modem is 28.8 KBPS, or sometimes in ideal circumstances it can not exceed 32 KBPS. As for Internet, the connection requires an expensive communications line (T1) and equipment. Furthermore, if a users do not want to invest in a T1 line, they would be restricted to use a modem to access an Internet service provider

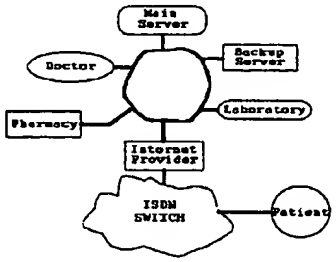

Fig. 1 MEDNET System Diagram

Therefore, the baud rate to communicate between an individual and the file server would be the same as a that of a POTS standard modem. On view of the current technologies such as ISDN, Frame Relay on the existing telephone network are becoming available and are widely accepted [2].

In this article, the authors present the hardware and software implementations of the MEDNET, being developed at FIU engineering laboratories.

SYSTEM CONSIDERATIONS

The hardware and software interfaces of the MEDNET system provide for a secure and user friendly access to patient data on the Medical Network. At the FIU Lab, MEDNET is implemented using ISDN and Internet communication technologies. The concept of the MEDNET system is portable to different network platforms. The hardware model consists of a SUN Sparc 10 workstation, a UNIX base computer with 64 Mg bytes RAM, a one Gigabyte hard drive, an NCD X-terminal, and PC-compatible computers with X-terminal software running under the Windows operating system. The SUN Sparc comes with an Internet interface card with an RJ45 connector. It also comes with built-in AT&T ISDN Terminal Adapter (TA). The Terminal Adapter of the file server workstation connects to a Network Terminator (NT), which in turn is connected to the ISDN switch at the Central Office (CO).

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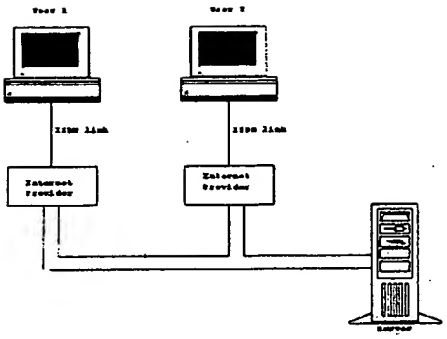

Fig. 2. Complete connection of two users to the MEDNET server through ISDN

On the other side of the ISDN line the user's system is connected to an ISDN switch in a similar fashion. Users of the MEDNET could be served by different Central Office switches. For example the file server could be connected to a Northern Telecom DMS-100 switch while one user could be connected to an AT&T 5ESS switch and another user connected to Siemens EWSD switch. FIGURE 2 shows the complete connection of two users.

OPERATING SOFTWARE

The operating software was designed for dynamic data base implementation, and implemented using GCC, the C++ compiler. For fast data access, the Binary-tree structure with automatic B-tree balancing algorithm is used. On the remote site the PC computer runs with X-terminal software under Windows, NCD X-terminal and Sun3/80.

The development guide graphical user interface is used for the development of the graphical interface of the MEDNET system. It supports the development of portable MEDNET system applications that can run on a variety of hardware and operating systems. In this particular project, the system model is tested using a Sun Sparc Station 10 on top of a X-windows system.

SYSTEM INTERFACE

Using the standard phone line requires a 14.4 KBPS modem, users can call directly to the terminal-server at the computer center where the file server is located. Once the connection is established, the system will direct the call to the file server. The terminal server provides multiple telephone access to the main system.

The workstation is connected to the Internet network. Users that desire to log-in, need to connect to an Internet services provider, and Telnet to the system with an X-terminal graphic program.

When a call is initiated by a remote user from a place like a hospital, the call is routed through various network nodes until it gets to the destination MEDNET server. FIGURE 4 shows the use of Internet to access the file server from client X-terminal.

ISDN is the best communication technology available to implement the MEDNET medical network. In comparison with standard POTS dial-up at the maximum rate of 28.8 KBPS to interconnect an Internet service provider, ISDN is much faster and more reliable. ISDN with it's end to end digital from the client X-terminal connectivity offers higher reliability and a speed of transmission of 64 KBPS per B channel. Medical doctors, like radiologists, could be on call at than more one hospital, and work more efficiently from one centralized location using high speed ISDN services for image transfer. MEDNET uses ISDN in both operations modes: CSD and PSD. In either mode, the system uses the full speed of 64 KBPS per channel. Furthermore, B channels could be bundled together as shown in FIGURE 3, to provide higher transmission bandwidth for medical imaging.

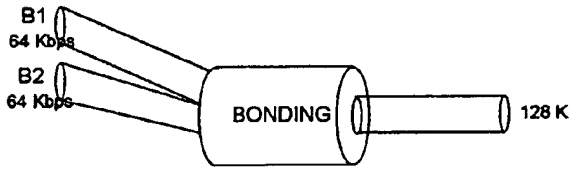

FIGURE 3 Two BRI channels bundled to provide 128 KBPS

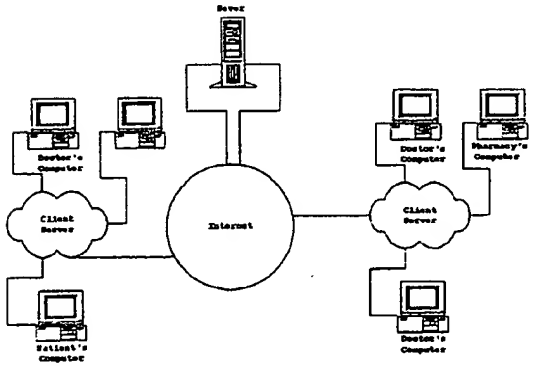

Fig. 4. Internet to access a file server

MEDNET FILE SERVER

The MEDNET file server has one ISDN external terminal adapter that interfaces to one B channel. FIGURE 6 shows the file server connection to ISDN.

The communication architecture of the doctor's office is to subscribe to the ISDN BRI service with two CSV B channels, and one PSD D channel. The CSV channels provide for voice access, and the data channel provide access to MEDNET. FIGURE 5 shows the communication architecture of the doctor's office.

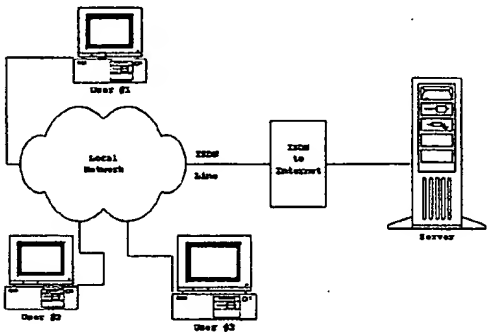

Fig.5. File sever connection to ISDN

MEDNET INTEGRATION

The integration of the MEDNET system allows medical personnel to communicate without the need for voice communication. In another words, once the user, such as the doctor, is in the MEDNET system, he/she will be able to call the pharmacist through the MEDNET system so that the two of them can converse through the network. Meanwhile, communicating parties' monitors display a picture of each another for validation purposes. Although one might presume this process time consuming, with ISDN in place, the communication delay is negligible to the user.

MEDNET CASE STUDY

The MEDNET system can initiate by the patient's call to the doctor. The doctor enters the name of the calling patient on the system, instantly the patient's picture appears on the doctor's monitor. Also, the doctor's picture appears on the patient's monitor. If for any reason the doctor needs to call the medical laboratory to obtain a lab result for the patient, then the doctor's and the patient's picture display on the laboratory's computer. Also, the laboratory personnel's picture is displayed on the doctor's monitor. Once the doctor's request has been processed by the lab personnel, the doctor would disconnect from the medical lab. The lab personnel's picture is erased from the doctor's monitor.

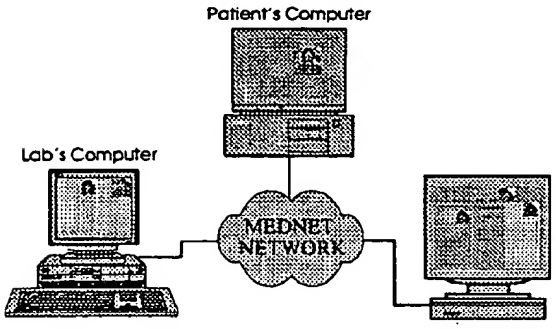

Fig.6. MEDNET system showing doctor's, patient's and lab's computers.

Once the doctor has received the patient's lab results and has formulated a diagnosis, then the doctor calls the pharmacist to provide all the necessary medication information. While conversing with the pharmacist, the doctor's and the patient's pictures are displayed at the pharmacist's terminal. At the same time the doctor has a picture of the pharmacist on his/her screen. The idea is that all the medical personnel are able to access each other's image and medical information (both text and image) while conversing through the MEDNET system. FIGURE 6 shows MEDNET with doctor's computer, patient's computer and lab's computer.

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